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The Effectiveness of Competing Regulatory Regimes and the Switching Effects? : Evidence from an Emerging Market.

Hisham Farag[1]

Abstract

I investigate the effectiveness of two competing regulatory regimes and the effect of switching from strict price limits to circuit breakers on volatility spillover, and also on trading interference hypotheses. I find that switching to the circuit breakers regime increases volatility and disrupts the price discovery mechanism. Stock prices are prevented from reaching their equilibrium levels and traders are unable to obtain their desired positions on limits hit day. Moreover, I find that volatility is spread out over the following two days post-limit hits within the strict price limits regime. Finally, results show that price limits interfere with trading activity and affect investors' beliefs and liquidity positions.

JEL classification number: G15

Key words: Price limits, circuit breakers, volatility and trading behaviour.

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1. Introduction

Price limits are regulatory tools in both equity and futures markets in which further trading is prevented for a pre-specified duration either across the whole market or for a particular stock - with the intention of cooling traders' emotions and reducing price volatility[2]. Price limits have become very popular and are widely used by different stock exchanges over the world. Despite the popularity of price limits, there is a remarkable debate in the academic literature regarding the effectiveness of such regulatory tools and whether or not they actually cool down market sentiment and reduce price volatility as intended. Chan et al (2005) argue that price limits are the main reason for order imbalance. Subrahmanyam (1994) finds that imposing circuit breakers increases price volatility rather than cooling the volatility. Lee et al. (1994) argue that the announcement of trading halts leads to a dispersion of investors' belief about the equilibrium prices, and thus some irrational traders are drawn to the market under the effect of excessive media coverage[3]. This results in an increase in both trading volume and volatility (Farag and Cressy, 2012).

Price limits may also cause price volatility to spread out over a few days post-limit hits (volatility spillover hypothesis); see for example Fama (1989), Kim and Rhee (1997), Chen (1997), George and Hwang (1995), and Chen et al. (2005). Moreover, it is argued that price limits prevent security prices from reaching their equilibrium levels, and disrupt the price discovery mechanism due to the suspension of trading for a period of time (Delayed price discovery hypothesis); see, for example, Fama (1989), Lehmann (1989), Lee et al. (1994), Kim and Rhee (1997) and Phylaktis et al. (1999). On the other hand, if trading is prevented by price limits then shares become less liquid, and this leads to intensive trading activity during the following trading days (trading interference hypothesis); see, for example, Fama (1989),

[2] Kim and Yang (2004) differentiate between three main categories of these regulatory tools, namely: price limits, firm-specific trading halts and market-wide circuit breakers. The trigger for price limits occurs when prices hit particular pre-specified price boundaries. With firm-specific trading halts, trading is ceased for a particular stock(s) for a given period of time within the session, or until the end of the trading session, if prices hit the predetermined limit. Finally, with market-wide circuit breakers, trading may be stopped - for a pre-specified duration – across the whole market if the market index hits a pre-determined level.

[3] Lee et al. (1994) find that trading halts increase both trading volume and stock price volatility by 230% higher than the following non-halt control. They argue that the media coverage plays an important role in explaining the post-halt price behaviour due to the increase in the heterogeneity of investors' beliefs.

Telser (1989), Lehmann (1989), Lauterbach and Ben-Zion (1993), Kim and Rhee (1997) and Corwin and Lipson (2000).

The existing body of literature on price limits investigates narrow/strict price limits (5% -7%) in many stock exchanges e.g. Taiwan, Tokyo and Athens Stock Exchanges, Chen (1997), Kim and Rhee (1997), Phylaktis et al. (1999). The empirical findings of these papers are mixed, therefore we can't really decide whether or not strict price limits decrease price volatility and cool down the market. No other studies – to the best of my knowledge - have investigated the potential effect of a switch from narrow price limits to wider limit bands. I investigate, in the context of the Egyptian stock market, the effect of the changes in regulatory policies on three main hypotheses, namely (i) the volatility spillover hypothesis, (ii) the delayed price discovery hypothesis, (iii) and the trading interference hypothesis. In addition, the paper investigates the impact of regulatory policies on the dynamic relationship between trading volume and volatility.

The literature on price limits investigates the above hypotheses only for stocks that hit and nearly hit their limits (0.90 of the upper and lower limit bands); see, for example, Kim and Rhee (1997) and Chen et al. (2005). However, no other studies – to the best of my knowledge - have empirically investigated the relative efficiency of the alternative price limit regimes (circuit breakers/price limits). One of the compelling reasons for studying price limits in the context of the Egyptian stock exchange is that it is a unique example of the switch from strict price limits (SPL) (+/-5%) to circuit breakers (CB). The switch is accompanied by a move to much wider price limits (+/-10% - 20%). There are only a few stock exchanges throughout the world that have switched to a wider price limits, e.g. Thailand from 10% to 30%, and the Korean Stock Exchange from 6% to 15%. Therefore, there is an obvious policy implication as we can identify the effect of regime change to wider limit bands on price volatility and trading behavior.

I find evidence – consistent with the volatility spillover hypothesis - that volatility is spread out over two days subsequent to limit hit day within the SPL regime. Moreover, the price discovery mechanism is disrupted when stocks experience greater volatility for a few days post-limit hits and therefore stock prices are prevented from reaching their equilibrium levels. These deviations from the true prices are expected to prevail within the SPL regime as trading is suspended until the following day (trading session) when the prices hit their limits.

However, within wider bands of limits followed by trading halts (CB), investors have a chance to adjust their portfolios' position within the same trading session. These results are consistent with Kim and Rhee (1997) and Lee et al (1994). The results also show that price continuations behaviour occurs more frequently within the SPL regime; however price reversal behaviour seems to occur more frequently within the CB regime. Finally, the results of the trading interference hypothesis show that there is a sharp increase in trading activity on event day (limit hit day) for both SPL and CB regimes as traders are unable to obtain their desired positions. The rest of the paper is organised as follows. Section 2 briefly describes the institutional background of the Egyptian Stock Exchange (EGX). Section 3 presents details of the econometric modeling and the empirical results. A summary and conclusion is presented in the final section.

2. The Institutional background of EGX

The Egyptian Stock Exchange (EGX) has become one of the biggest and most promising emerging markets in the Middle East and North Africa region[4], having grown substantially since the beginning of the Egyptian economic reform and privatisation program in the mid-1990s. The Egyptian Stock Market achieved reasonable performance indicators during 2008-2010 even though the negative impact of the global financial crisis that affected the vast majority of the stock markets throughout the world. It was classified by the Economist in 2010 as one of the best six emerging markets (CIVETS)[5] offering significant potential growth over the next decade. In addition, the World Federation of Exchanges' (WFE) statistics in 2010 reported that it had achieved an average gain of 15%, ahead of many leading world emerging stock exchanges e.g. China, Brazil, and Czech Republic, and ahead of all Arab stock markets except for Qatar (25%) and Casablanca (21%). The Standard and Poor's S&P IFCI reported that the average growth rate for the EGX during 2010 was 13% in US$ compared with the average growth rate for other emerging markets (12%).

[4] For more details see the World Federation of Exchanges (WFE) statistics. Some institutional factors, such as neither capital gain nor dividends are taxed ,distinguish the Egyptian stock market from other emerging markets.
[5] Colombia, Indonesia, Vietnam, Egypt, Turkey and South Africa

The EGX has a unique history of price limit regimes; this makes studying it – (amongst few other stock exchanges e.g. Korean and Thailand) - interesting. Since 1996, EGX trading regulations have imposed strict (+-5%) price limits (SPL) for all the listed shares. The limit is activated for a particular stock only when stock prices hit the upper or lower limit, at which point the trading on these shares is suspended to the end of the trading session. In 2002 the regulator commenced a new price ceiling system, namely, circuit breakers (CB) in which the price limits have winded to +-20% for the most actively traded shares in the EGX. Within the new CB regime, trading is halted for 30 minutes when a particular stock price hits +-10%. During the 30-minute trading halt, brokers should inform their clients about the temporary suspension of the trading session. In addition they are allowed to cancel or adjust traders' orders to adjust their portfolio positions. Trading is ceased only when prices hit their ceiling of +/- 20%.

3. Data, Econometrics Modeling and empirical results

The dataset consists of daily[6] open, high, low and closing prices for all listed[7] shares in the EGX over the period 1999-2010[8]. I use the EGX30 - a free-float market capitalization weighted market index[9] as a benchmark. I also collect data on trading volumes and market capitalisation as a proxy for trading activity and size respectively. I define the event as being when a stock hits its upper or lower limits (+/-5%) within the SPL regime and when a stock hits its upper or lower limits (+/-10%) pre trading halts within the CB regime[10]. The total number of events is 4221 hits over the period 1999-2010 of which 1655 and 771 events are associated with +5% and +10% upper limit hits respectively. Whereas 1174 and 621 events are associated with -5% and -10% lower limit hits respectively. To investigate the volatility spillover, the delayed price reaction and the trading interference hypotheses, and to compare the switching effects from the SPL to the CB regime, I extend and augment the methodologies

[6] I adjusted the daily prices for dividends, stock dividends, and stock split.
[7] The number of listed companies in 2010 is 211 companies.
[8] I also estimate the three hypotheses over the period 1999-2005 so that the two windows (SPL and CB) are symmetric (4 years each) and to avoid any negative impact of the global financial crisis. I obtained similar results.
[9] I also used other equally weighted indices e.g. EFG as a benchmark and obtained similar results.
[10] There are only a few events (prices hitting their ceiling (20%) post trading halts, therefore, I did not include these in the analysis. However, this will be investigated in a future extension of this paper.

of Fama (1989), Lauterbach and Ben-Zion (1993), Kim and Rhee (1997) and Chen et al. (2005) using the augmented EGARCH model.

3.1 Volatility Spillover hypothesis

To investigate the Volatility Spillover (VS) hypothesis, for each event, I identify days (events) where the high price during the trading session matches its previous day's closing price plus the price limit band (-/+5%) or (-/+ 10%) for the SPL and CB regimes respectively. For the upper limits I assume:

$$H_t = C_{t-1}(1 + PLB_t) \qquad (1)$$

And for lower limits I assume:

$$L_t = C_{t-1}(1 - PLB_t) \qquad (2)$$

Where:

H_t : is day's high price.

L_t : is day's low price.

C_{t-1} : is previous day's closing price.

PLB_t : is the price limit bands for day (t) (+/-5% or +/-10%) according to the regime in operation (SPL or CB).

I define daily price volatility[11] in the fashion of Kim and Rhee (1997) and Chen et al. (2005) as in equation 3:

$$V_{tj} = R_{tj}^2 \qquad (3)$$

Where: V_{tj} is the volatility of stock (*j*) on day (*t*). R_{tj} is the close-to-close return for stock j on day t, measured by the log of the firm's price ratio i.e. $R_t = \ln P_t / P_{t-1}$ where P_t is the closing price of the stock on day (t). I calculate the daily price volatility R_{tj}^2 for each stock in the four categories (upper and lower +/-5% or +/-10%) and then take the daily averages. I then estimate the volatility during 21 days (-10, +10) around event day. To overcome potential bias in volatility estimation I include only non-overlapping event windows. This reduces the sample size for the stocks that hits their limits by 19.2% (from 4221 to 3542). I use the

[11] I also estimate daily volatility using the daily high-low range and obtained similar results.

nonparametric Wilcoxon signed–rank test to compare volatility levels for upper and lower limits. The null hypothesis is "The distribution is centered on zero difference".

Chen et al. (2005) use the symmetric GARCH model to examine the effect of imposing price limits on price volatility in both the Shanghai and Shenzhen Stock Exchanges. I argue that the asymmetric EGARCH model has many advantages over the symmetric GARCH as the estimation has no negative parameters ($\log \sigma_t^2$ is positive), and so, no non-negativity constraints need to be imposed on the model parameters as in theTARCH-GJR model. To further investigate the effect of regime switch on price volatility, I estimate the Asymmetry Exponential GARCH model (EGARCH of Nelson, 1991) for the EGX30 market index over the period 1999-2010 and augment it by adding a price limit dummy variable as in equation 4. Leverage effect (the effect of positive and negative shocks on the future conditional volatility) is allowed, and the parameter γ is expected to be negative in sign if the relationship between return and volatility is negative. The leverage effect in the EGARCH model is exponential rather than quadratic and can be tested by the hypothesis that $\gamma < 0$. The impact is asymmetric if $\gamma \neq 0$. The volatility persistence is measured by β to examine whether big (small) shocks are followed by bigger (smaller) shocks.

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{\mu_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|\mu_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \eta\, CB_t \tag{4}$$

where: $\ln(\sigma_t^2)$ is the conditional variance of return at time (t), $\beta \ln(\sigma_{t-1}^2)$: is the conditional variance at time (t-1), $\alpha \left[\frac{|\mu_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right]$ is the effect of the shock (i.e. new information arrival) on conditional volatility, $\gamma \frac{\mu_{t-1}}{\sqrt{\sigma_{t-1}^2}}$ is the effect of positive and negative shocks on conditional volatility (leverage effect) and CB_t is a dummy variable takes the value of 1 if the CB regime is in operation on day t; and zero if the SPL regime is in operation. The sign of η will be positive or negative as switching regimes increase or decrease volatility. Nelson (1991) assumed that the error term follows the Generalized Error Distribution[12] (GED).

[12] I use the Berndt- Hall-Hall-Hausman (BHHH) technique to maximize the log likelihood function of the GED.

Table 1 presents the results of the volatility spillover hypothesis. *Panel A* shows that the highest volatility is reported on event day for both upper and lower limits for the two regimes. For the upper limit hits, for instance, we notice a large drop in volatility on day one from 2.5 to 1.57 and from 10 to 0.81 for the SPL and CB regimes respectively. However, volatility drops from 2.5 to 1.28 and from 10 to 0.89 for the SPL and CB regimes respectively for the lower limit hits. Ma et al. (1989) explain this as the cooling effect of price limits; however Kim and Rhee (1997) and Lee et al. (1994) conclude that volatility measures will naturally decline when stocks hit their limits. We also notice that volatility within the CB regime is greater than those of the SPL except for the first two days post-upper limit hits and for the first day post-lower limit hits[13]. This suggests that within the SPL regime, stocks that hit their upper and lower limit continue to experience greater volatility during the first 1-2 days post-event compared with the CB regime. This result is consistent with the volatility spillover hypothesis. Moreover, the volatility post-limit hits are greater than those of the pre-limits for two and three days for the lower and upper limits respectively. For example, within the upper SPL, post-limits volatility is greater than those of pre-limits by 286%, 377% and 82% respectively. Similarly, within the upper CB regime, post-limits volatility is greater than those of pre-limits by 45%, 127% and 47% respectively. Finally, the Wilcoxon signed–rank test shows that the differences between the two regimes are significantly different from zero at the 0.01 and 0.05 levels on event day and over the first three days post-event[14].

Panel B presents the results of the augmented EGARCH model. The model is well specified as the log likelihood estimation is big compared to the symmetric GARCH model[15]. This suggests that the EGARCH model fits the daily returns time series of the EGX30 and the temporal dependence of return volatility can be captured by the model.

[13] Volatility within the upper SPL regime is greater than that of the CB regime by 93%, and 66% during the first two days post-event respectively. However, volatility within the lower SPL is greater than that of the CB regime by 43% on day one post-event.

[14] To investigate the size effect on volatility within the two competing price limits regimes, I repeat the analysis of the volatility spillover hypothesis for two sub-samples, namely big and small companies based on their market capitalisation. I find similar results as those presented in Table 2; therefore, I conclude that there is no size effect on volatility spillover for the two regimes. The results are not presented but available from the author upon request.

[15] The log likelihood estimation of GARCH model is 4964.

Table 1
Volatility Spillover Hypothesis

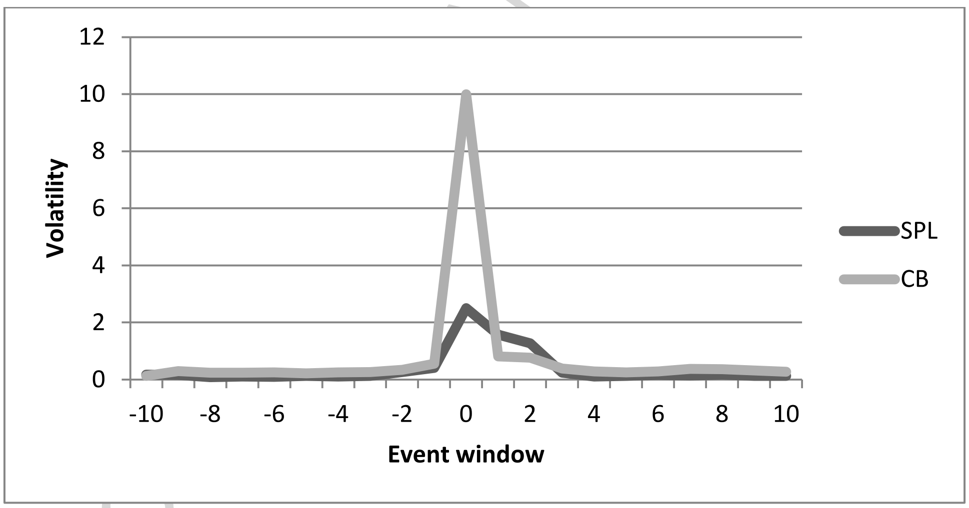
Panel A: Volatility Spillover Hypothesis						
Days	**Upper limits**			**Lower limits**		
	+5%		+10%	-5%		-10%
-10	0.1768		0.1291	0.2200		0.2241
-9	0.1653		0.2984	0.2190		0.2216
-8	0.0827		0.2414	0.2813		0.2450
-7	0.1095		0.2422	0.1933		0.2936
-6	0.0957		0.2490	0.2071		0.3542
-5	0.1349		0.2239	0.2373		0.2214
-4	0.1110		0.2568	0.2398		0.2440
-3	0.1333	<	0.2644	0.2430		0.3259
-2	0.2667		0.3379	0.2541	<	0.4071
-1	0.4072		0.5560	0.3694	<<	0.6695
0	**2.5000**	<<	**10.0000**	**2.5000**	<<	**10.0000**
1	**1.5723**	>>	**0.8088**	**1.2797**	>>	**0.8947**
2	**1.2739**	>>	**0.7680**	0.3649	<	0.4448
3	0.2427	<<	0.3895	0.2962	<<	0.4770
4	0.1107	<	0.2857	0.1309		0.2409
5	0.1277		0.2572	0.1727		0.2115
6	0.1586		0.2876	0.2138		0.2883
7	0.1432		0.3813	0.1735		0.4051
8	0.1745		0.3598	0.1752		0.2809
9	0.1326		0.3249	0.1400		0.3169
10	0.1343		0.2779	0.2005		0.2590

Panel B: Augmented EGARCH estimation for EGX30		
	Coefficient	SE
ω	-0.4949^{***}	(0.0704)
β	0.9686^{***}	(0.0068)
γ	-0.0281^{*}	(0.0167)
α	0.0371^{***}	(0.0135)
η	0.0296**	(0.0142)
Log likelihood	5680	
Ljung-Box $Q_{(20)}$	35.831	
Ljung-Box $Q^2_{(20)}$	18.634	
LMARCH	1.1435	

The table presents the results of volatility spillover hypothesis for the two regimes as in equation 3. Volatility is measured by squared stock returns multiplied by 1000. >> and > implies that the left hand figure is significantly greater than the right hand figure at 0.01 and 0.05 significance levels respectively using Wilcoxon signed-ranked test. Panel B presents the results of the augmented Exponential Generalized autoregressive GARCH model as in equation 4. ***, **,* indicate significance at the 1%, 5% and 10% levels.

The volatility persistence coefficients α and β are highly significant, however β is greater in magnitude than α ; this implies that the bigger the market shocks the relatively smaller expected volatility. The leverage effect is negative as expected; this suggests that negative shocks have greater impact on conditional volatility in the EGX. Most importantly, the CB coefficient η is positive in sign and highly significant; this suggests that the switch from SPL to CB increases future volatility. Furthermore, we can reject the null that the residuals are serially uncorrelated and homoskedastic as the results of the Ljung-Box $Q_{(20)}$ and Ljung-Box $Q^2_{(20)}$ for serial correlation and the $LMARCH_{(20)}$ for heteroskedastisity are insignificant. Figure 1 presents the average price volatility for the upper limits for the two regimes around event day[16].

Figure I. Average price volatility for the upper limits for the two regimes



To conclude, the results show that price limits do not decrease volatility as intended in both regimes (SPL and CB). However, volatility is found to be higher within the CB regime. On the other hand, within the SPL regime, volatility is spread out over two days subsequent to limit hit day. These results support the volatility spillover hypothesis in the Egyptian Stock Exchange and are consistent with findings of Kim and Rhee (1997), Lee et al (1994) and Chen et al. (2005).

[16] The figure of the average price volatility for the lower limits is pretty much similar to Figure 1.

3.2 The delayed price discovery hypothesis

Stocks often experience either price continuation or price reversal based on overnight returns. I compare the price behaviour of the two regimes (SPL and CB), so that if price continuation behaviour within SPL is greater than that within the CB regime then we can infer that the efficient price discovery mechanism is much delayed within the SPL regime and the opposite is correct. Price continuation behaviour prevents stock prices from reaching their equilibrium levels, since otherwise we should observe price reversals or overreactive behaviour (Roll, 1983). Price limits interfere with the price discovery mechanism as trading usually ceases (when prices hit the limit) until the limits are revised. Therefore, at the limit-hit day these constraints (limits) prevent stock prices from reaching their equilibrium levels until the following trading day (session) (Fama, 1989, Lehmann, 1989, and Lee, Ready, and Seguin, 1994).

According to the Delayed Price Discovery (DPD) hypothesis there will be positive overnight returns for stocks that hit their upper limits, and negative overnight returns for stocks that hit their lower limits. To investigate these claims I estimate the following two returns series following Kim and Rhee (1997) and Chen et al. (2005): namely open-to-close returns on the limit day, $R(O_0C_0) = \ln(C_0 / O_0)$ and close-to-open returns between the event day and the following day, $R(C_0O_1) = \ln(O_1 / C_0)$, where C_0 is the closing price on day (t) and O_1 is the opening price on day (t+1). Stock returns can be positive, negative or zero; therefore, we have nine return series (+, +), (+, 0), (0, +), (0, -), (0. 0), (+, -), (-, +), (-, -) and (-, 0) as shown in Table 2. The first return symbol represents $R(O_0C_0)$ and the second return symbol represents $R(C_0O_1)$.

Table 2
Classifications of price continuations and price reversals for the upper and lower limits

	Upper Limits	**Lower Limits**
Price continuation	(+, +) and (0, +)	(-, -) and (0, -)
Price reversal	(+, -), (0, -), (-, +), (-, 0) and (-, -)	(-, +), (0, +), (+, -), (+, 0) and (+, +)
No change	(+,0) and (0,0)	(-, 0) and (0, 0)

Note: The first return symbol represents the open-to-close returns on the limit day $R(O_0C_0) = \ln(C_0 / O_0)$ and the second return symbol represents the close-to-open $R(C_0O_1) = \ln(O_1 / C_0)$

As can be seen from Table 2, I classify both (+, +) and (0, +) as price continuations for the upper limit hits. The (0, +) return series is classified as price continuation because these stocks experience an overnight price increase (stocks open at the upper limit and remain unchanged over the event day). The same concept applies to the lower limits as I classify both (-, -) and (0, -) return series as price continuations (Kim and Rhee, 1997, Chen et al., 2005, Bildikand Gulay, 2006). On the other hand, I classify (+, -), (0, -), (-, +), (-, 0) and (- , -) as price reversals for the upper limits. I also consider (-, +), (-, 0) and (-, -) returns series as price reversals because the first negative sign (open-to-close returns) implies price reversal before the end of the trading session on event day (Kim and Rhee, 1997, Chen et al., 2005). I also classify (-, +), (0, +), (+, -), (+, 0) and (+, +) as price reversals for the lower limits. Finally, I classify (+, 0) and (0, 0) as no-change category for the upper limits and the (-, 0) and (0, 0) as no-change category for the lower limits (Kim and Rhee, 1997, Bildik and Gulay, 2006). I use the standard nonparametric binomial Z-test to investigate the significant differences between the two regimes with respect to price continuations and price reversals following Kim and Rhee (1997) and Bildik and Gulay (2006).

I estimate the proportions of price continuations, price reversals and no changes categories over the period 1999-2010 for the two regimes as in Table 3[17]. For the upper limits, Table 3 shows that price continuations occur 74.7% and 51.04% of the time for the SPL and CB regimes respectively. However, price reversals occur 24.88% and 47.15% of the time for the SPL and CB regimes respectively over the same period. The no change events occur 0.42% and 0.81% of the time for the SPL and CB regimes respectively. For the lower limits, price continuations occur 69.15% and 47.58% of the time while price reversals occur 30.15% and 52.40% of the time for the SPL and CB regimes respectively. Finally, the nonparametric binomial Z test shows that there is a significant difference between the two regimes regarding price continuations and price reversals.

[17] Following Kim and Rhee (1997) and Bildik, and Gulay (2006), consecutive event days are not excluded from the analysis as they will underestimate the frequencies of price continuation and price reversals.

Table 3

Proportions of price continuations and reversals for the SPL and CB regimes.

Price Behaviour	Upper limits			Lower limits		
	SPL (%)	**CB (%)**	**SPL-CB (z- stat)**	**SPL (%)**	**CB (%)**	**SPL-CB (z-stat)**
Price Continuation	74.70	51.04	5.7737***	69.15	47.58	7.9097***
Price Reversal	24.88	47.15	-8.9936***	30.15	52.40	-5.3111***
No. change	0.42	0.81	-1.2568	0.70	0.02	1.5987

The table presents the limit hit frequencies for the two regimes namely SPL (strict price limits) and CB (circuit breakers).

To summarise, the results show that price continuation behaviour occurs more frequently within the SPL regime. However, price reversal behaviour seems to occur more frequently within the CB regime. This implies that the price discovery mechanism is delayed by the SPL. This result supports the delayed price discovery hypothesis as price limits prevent stock prices from reaching their equilibrium levels, in particular within the SPL regime.

3.3 The Trading Interference hypothesis.

The Trading Interference (TI) hypothesis claims that trading volume (as a proxy for trading activity) will be higher for stocks that hit their upper or lower limits for a few days post-event (Lauterbach and Ben-Zion, 1993 and Bildik and Gulay, 2006). Fama (1989), Telser (1989), Lauterbach and Ben-Zion (1993) and Kim and Rhee (1997) claim that if trading is prevented by price limits, then shares become less liquid and this leads to intensive trading activity during the following trading days. Lehmann (1989) argues that order imbalances are corrected in the following days post-event as informed traders will wait until the prices reach their equilibrium levels. As we expect that price limits will prevent rational trading on the event day, trading volume is therefore expected to continue increasing over the post-event days.

To investigate the trading interference hypothesis around limit-days, following Kim and Rhee, (1997) and Chen et al. (2005), I calculate the percentage change in the turnover ratio for each stock in the two regimes as in Equations 5 and 6 and then take averages for each day over the

21- day window (-10, +10)[18]. Table 4 presents the results of the trading interference hypothesis.

$$\%\Delta TA_{jt} = \ln(TA_{jt} / TA_{jt-1}) \tag{5}$$

$$TA_{jt} = Vol_{jt} / No. of\ \ shares \tag{6}$$

where: TA_{jt} is the turnover ratio as a proxy for trading activity of stock (j) at time (t).

Vol_{jt} is a daily trading volume for stock (j) at time (t).

It is clear from Table 4 that there is a sharp increase in trading activity on event day for both the SPL and CB regimes. For the upper limits, Table 4 reports that the percentage increases in trading activity on event day are 51.26% and 77.03% for the SPL and CB regimes respectively. Moreover, trading activity on event day is significantly greater compared with the 10 days post- event. We also notice that the increase in trading activity lasts for two days (45.15% and 36.69%) post-event within the SPL, and lasts only for one day (40.50%) following the event within the CB regime.

For the lower limits, the highest trading activity – as expected – is reported on event day: 42.84% and 67.15% for the SPL and CB regimes respectively. We also notice that the increase in trading activity lasts only for one day (24.89%) following the event within the SPL regime. However, we find a significant decrease in trading activity one day following the event within the CB regime. Finally, trading activity within the CB regime – on average – is higher than that of the SPL for four days pre-event for the upper and lower limits.

I interpret the above results as follows: within the SPL regime, traders are unable to obtain their desired positions or to adjust their portfolios on event day and are forced to wait until the following trading session. On the other hand, within the CB regime, investors have the chance to adjust their portfolios during the same trading session[19]. However, not all investors are

[18] I exclude the consecutive events during the limit window (-10, +10) to be consistent with volatility spillover (VS) hypothesis analysis.

[19] Greenwald and Stein (1988) and (1991) are the main proponents of trading halts. They argue that trading halts provide a suitable time for the dissemination of information between brokers and traders, so that large price

informed about the suspension of trading due to the lack of informational efficiency in emerging markets. Therefore, only one day following the event (in the case of upper limits) may be required to adjust the portfolios' position. This result suggests that price limits interfere with trading activity and affect the liquidity positions within the two regimes. These findings are consistent with Lehmann, (1989).

Table 4
Trading interference hypothesis: Turnover ratio

Days	**Upper limits**			**Lower limits**		
	+5%		+10%	-5%		-10%
-10	-0.0498		0.0227	-0.0380		0.0012
-9	-0.0462		0.0249	-0.0354		-0.1074
-8	-0.0716		-0.1658	0.2126	>	0.1201
-7	0.1791	>	0.0855	0.0274		-0.0336
-6	-0.0151		0.1044	-0.1268		0.1127
-5	-0.1385		-0.1485	0.1669		-0.0172
-4	0.0569		0.1480	-0.0857		-0.0704
-3	0.0511		0.1052	-0.0368		0.0583
-2	-0.0475		0.0958	0.1470	<	0.1701
-1	0.2578	<	0.4053	-0.1330		-0.0453
0	**0.5126**	<<	**0.7703**	**0.4284**	<<	**0.6715**
1	0.4515	>>	0.4050	0.2489	>>	-0.3751
2	0.3669	>>	-0.2302	-0.1296		0.0618
3	-0.1578		0.1976	0.0929		0.1522
4	-0.0168		-0.0079	0.0722	<<	0.1550
5	-0.1162		-0.0345	-0.0526		-0.0355
6	-0.1133		-0.0236	-0.0563	<<	0.1122
7	-0.0534	>>	-0.1374	0.0607		0.0935
8	-0.1176		0.0078	-0.0568		-0.0183
9	-0.0256	<<	0.1283	0.1099		-0.0457
10	0.0179		0.0686	-0.1377	<<	-0.0461

The table presents the results of the trading interference hypothesis for the SPL and CB regimes as in equation 5. >> and > implies that the left hand figure is greater than the right hand figure at 0.01 and 0.05 significance respectively using Wilcoxon signed-ranked test.

3.4 Regulatory policies and volume-volatility relationship.

In this section, I investigate the relationship between regulatory policies and volume-volatility dynamics. Corwin and Lipson (2000) find a higher volume of order submissions and

movements are expected post halts. Greenwald and Stein (1988) claim that these large price movements are not a cause for concern as long as there are no asymmetries of information between the traders and specialists. On the other hand, Fama (1989) argues that trading halts historically failed to cool markets down and to decrease price volatility. In contrast, volatility is found to be higher under such halts (Lee, Ready, and Seguin (1994). Fama also believes that all investors implement their own trading halts if they wish to analyse the disseminated information; these are called "homemade'' trading halts.

cancellations around trading halts; this suggests that investors are trying to adjust their portfolios during the halt period. It is well documented that there is a positive relationship between trading volume and price volatility which is often explained by the Mixture of Distributions Hypothesis of Clark (1973), subsequently developed by Epps and Epps (1976) and Tauchen and Pitts (1983). An alternative explanation is provided by the Sequential of Information Arrival hypothesis (SIAH) of Copeland (1976). To explore further the trading interference hypothesis, I run a cross-sectional regression – following Kim and Rhee (1997) - for the 21-day window separately for both upper and lower limits within the two regimes as in equation 7[20].

$$V_j = \alpha + \beta_1 (TA)_j + \beta_2 CB_j + \varepsilon_j \qquad (7)$$

where:

V_j : Squared stock returns as a measure of price volatility.

TA_j : The percentage change of turnover ratio as a proxy of trading activity[21].

CB_j : A dummy variable equals 1 for stocks that reach their upper or lower limits within the CB regime, and equals 0 within the SPL regime.

According to the trading interference (TI) hypothesis, I expect a positive relationship between trading activity and price volatility during the 21-day window[22]. However, in day 0, I do not expect this relationship to continue, as price limits interfere with trading activity. The sign of the CB – dummy is expected to be positive and significant around event day. This implies an increase in price volatility due to regime switch from SPL to CB. Table 5 reports the results of the OLS regressions of equation 7.

The models are well specified as the F stat. is highly significant and the adjusted R squared is reasonably high on event day. As expected, Table 5 reports a positive relationship between turnover ratio and volatility over the 21-day window for the upper and lower limits. However, this relationship is much stronger and highly significant around event day for the upper and lower limits.

[20] I also controlled for company size (natural logarithm of market capitalization) and obtained similar results. I did not present this variable due to the correlation with turnover ratio.

[21] I use the turnover ratio as a proxy for trading activity instead of trading volume per se as Farag and Cressy (2012) find that there is an endogeneity between trading volume and price volatility.

[22] I exclude the consecutive events for the sake of consistency with the volatility spillover hypothesis analysis.

Table 5
Volume- volatility relationship for the upper and lower limits

Day	Intercept	CB	TR	Adj R^2	F.value	Intercept	CB	TR	Adj R^2	F.value
	Panel A: Upper limits					*Panel B: Lower limits*				
-10	0.0013*** (0.0002)	0.0004** (0.0002)	0.00004 (0.0001)	0.007	2.645*	0.0010*** (0.0001)	0.0003* (0.0001)	0.00003 (0.0001)	0.004	1.790
-9	0.0014*** (0.0002)	0.0007*** (0.0003)	0.0002* (0.0001)	0.020	5.705***	0.0012*** (0.0001)	0.0005*** (0.0002)	0.00001 (0.0001)	0.014	3.480**
-8	0.0015*** (0.0001)	0.0010*** (0.0002)	0.0003*** (0.0001)	0.077	19.54***	0.0010*** (0.0001)	0.0003** (0.0001)	0.0001* (0.0001)	0.022	5.106***
-7	0.0012*** (0.0001)	0.0006*** (0.0002)	0.0002** (0.0001)	0.034	8.823***	0.0017*** (0.0002)	0.0010*** (0.0003)	0.0003* (0.0001)	0.032	6.924***
-6	0.0017*** (0.0002)	0.0011*** (0.0003)	0.0003 (0.0002)	0.056	14.14***	0.0019*** (0.0003)	0.0013*** (0.0004)	0.0001 (0.0002)	0.028	6.097***
-5	0.0013*** (0.0001)	0.0006*** (0.0002)	0.0004*** (0.0001)	0.024	6.427***	0.0014*** (0.0002)	0.0008** (0.0003)	0.00003 (0.0001)	0.011	2.925*
-4	0.0014*** (0.0002)	0.0008*** (0.0002)	0.0003** (0.0003)	0.038	9.720***	0.0011*** (0.0001)	0.0006*** (0.0002)	0.0001 (0.0001)	0.029	6.244***
-3	0.0140 (0.0843)	0.0834 (0.1092)	0.1182*** (0.0417)	0.015	4.366**	0.0038*** (0.0008)	0.0032*** (0.0011)	0.00004** (0.0002)	0.017	4.107**
-2	0.0012*** (0.0001)	0.0006*** (0.0002)	0.0004** (0.0004)	0.041	10.29***	0.0020*** (0.0003)	0.0012*** (0.0004)	0.0005** (0.0002)	0.029	6.200***
-1	0.0030*** (0.0003)	0.0025*** (0.0003)	0.0006*** (0.0001)	0.167	45.36***	0.0054*** (0.0008)	0.0046*** (0.0011)	0.0004** (0.0002)	0.041	8.479***
0	**0.0177*** (0.0004)**	**0.0152*** (0.0005)**	**0.0002 (0.0002)**	**0.654**	**78.36*****	**0.0180*** (0.0005)**	**0.0151*** (0.0007)**	**-0.0002 (0.0003)**	**0.573**	**36.00*****
1	0.0037*** (0.0002)	0.0024*** (0.0003)	0.0004 (0.0003)	0.153	41.03***	0.0021*** (0.0002)	0.0010*** (0.0003)	0.0002 (0.0002)	0.041	8.506***
2	0.0014*** (0.0002)	0.0006*** (0.0002)	0.0003*** (0.0001)	0.016	4.662***	0.0023*** (0.0002)	0.0016*** (0.0003)	0.0002** (0.0001)	0.072	14.51***
3	0.0012*** (0.0001)	0.0004*** (0.0002)	0.0002*** (0.0001)	0.028	7.363***	0.0018*** (0.0002)	0.0010*** (0.0002)	0.000** (0.0001)	0.042	8.614***
4	0.0016*** (0.0002)	0.0008*** (0.0002)	0.0002*** (0.0001)	0.037	9.478***	0.0013*** (0.0001)	0.0006*** (0.0002)	-0.0001* (0.0001)	0.043	8.762***
5	0.0014*** (0.0001)	0.0005*** (0.0002)	0.0002*** (0.0001)	0.032	8.382***	0.0012*** (0.0001)	0.0005** (0.0002)	0.0001 (0.0001)	0.014	3.438**
6	0.0018*** (0.0002)	0.0010*** (0.0003)	0.0002** (0.0001)	0.038	9.681***	0.0018*** (0.0002)	0.0010*** (0.0003)	0.0001 (0.0001)	0.028	5.949***
7	0.0011*** (0.0001)	0.0004** (0.0002)	0.0001* (0.0001)	0.015	4.451**	0.0015*** (0.0002)	0.0009*** (0.0003)	0.0002 (0.0002)	0.016	4.125**
8	0.0017*** (0.0002)	0.0011*** (0.0003)	0.00002 (0.0001)	0.032	8.428***	0.0008*** (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	-0.002	0.723
9	0.0014*** (0.0001)	0.0008*** (0.0002)	0.0003*** (0.0001)	0.064	16.151***	0.0012*** (0.0002)	0.0004** (0.0002)	0.0002* (0.0001)	0.013	3.371**
10	0.0012*** (0.0001)	0.0004*** (0.0002)	0.0001* (0.0001)	0.021	5.815***	0.0013*** (0.0002)	0.0006* (0.0003)	0.0002 (0.0001)	0.0116	3.047**

The table presents the results of the cross-sectional regression of equation 7. ***, **,* indicate significance at the 1%, 5% and 10% levels.

Interestingly, I find an insignificant volume–volatility relationship on event day and on the first day post-event for both upper and lower limits. This suggests that price limits and circuit breakers disrupt trading activity. This result is consistent with the trading interference hypothesis. On the other hand, results show that the dummy variable (CB) is positive and highly significant for the upper and lower limits. This suggests that switching from SPL to CB does increase volatility rather than cooling down the market as was intended. These findings are consistent with the volatility spillover hypothesis as regulatory policies (not trading activity) cause volatility to spread out over a few days post-limit hits. To support the analysis, I re-estimate Equation 4 using an augmented EGARCH model by controlling for trading volume as a regressor in the conditional variance equation and find positive and highly significant volume –volatility relationship[23].

4. Summary and conclusion

I investigate the effect of regulatory policies (price limits and circuit breakers) on three main hypotheses, namely, volatility spillover, the delayed price discovery and the trading interference hypotheses in the Egyptian Stock Market (EGX).

One of the compelling reasons for studying price limits in the context of the EGX is that it uniquely provides an example of the switch from strict price limits (SPL) to circuit breakers (CB). I find that price limits do not decrease volatility as intended in both regimes (SPL and CB). However, volatility is found to be higher within the CB regime whereas, within the SPL regime, volatility is spread out over two days post-limit hit day. This result is consistent with the volatility spillover hypothesis (Kim and Rhee, 1997, Lee et al., 1994 and Chen et al., 2005). I also find that price continuation behaviour occurs more frequently within the SPL regime. However, price reversals seem to occur more frequently within the CB regime. This result is consistent with the delayed price discovery hypothesis as price limits prevent stock prices from reaching their equilibrium levels, in particular within the SPL regime. Moreover, I find a sharp increase in trading activity on event day for the two regimes. This result suggests that price limits interfere with trading activity and affect investors' liquidity positions (Lehmann, 1989 and Kim and Rhee, 1997). Finally, the results of the volume volatility relationship suggest that regulatory policies disrupt trading activity according to the trading interference hypothesis.

To conclude, the above results show that switching from the SPL to the CB does increase price volatility in the Egyptian stock market. A potential interpretation of this result is as follows: price limits may prevent speculative traders from responding to the new information and

[23] Results are not presented but are available from the author upon request.

adjusting their portfolios. Within the SPL regime, traders are unable to obtain their desired positions on event day. This implies that the price discovery mechanism is disrupted when stocks experience greater volatility for a few days post limit hits, therefore stock prices are prevented from reaching their equilibrium levels for few days post-event. These deviations from the true prices are expected to prevail within the SPL regime (Farag and Cressy, 2012). I claim that the price discovery mechanism in the Egyptian Stock Market varies between the SPL and CB regimes. Within the SPL, as prices hit the limit, trading is suspended until the end of the trading session, therefore volatility is expected to spread out over the following day(s), Meanwhile, investors have more time (until the following day) to analyse and to react to the new information, and then adjust their portfolios accordingly.

On the other hand, within the CB regime, when prices hit the limits, trading is suspended for 30 minutes. During this relatively short time investors have the chance to adjust their portfolios based on the new information arriving in the market (Farag and Cressy, 2012). However, due to the lack of informational efficiency in the Egyptian Stock Market not all investors are being provided with the new information. Therefore investors are unable to reveal their demand during the halt period. This suggests that stock prices are expected to be much noisier post halt period and significantly different from their equilibrium levels. I argue that since herding and noise trading are dominant behaviours in emerging markets, intense trading activity is expected to continue by some speculative traders when a trading session is resumed. Moreover, the media coverage plays an important role in affecting investors' beliefs within a trading halt period (Lee et al., 1994). As a result, higher volume and volatility are expected when trading is resumed (Lee et al., 1994 and Farag and Cressy, 2011).

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